Most radiological work controls, including time limits on worker exposures to uranium, were based on the assumptions that the primary risks for uranium exposure were chemical, not radiological, and that uranium was soluble and would be eliminated by the body quickly through the kidneys. Thus, inhalation protection was encouraged, and bioassay urinalysis was employed from Plant startup to monitor intakes by workers who might be exposed to uranium or fluoride materials. However, the solubility assumption may not have been appropriate for some Plant areas, such as the metals plant and grinding and welding operations, where small particle sizes and relatively insoluble uranium compounds were present.

Limitations were established for uranium and fluoride levels and excretion rates, and personnel were removed from work areas with potential exposure until concentrations returned to acceptable levels. In 1968, in vivo radiation monitoring by lung counting was initiated, first by sending workers to Fernald or to Oak Ridge and later using a mobile counter periodically sent to PGDP from Oak Ridge. The intent of in vivo counting was to determine the activity of radionuclides trapped inside the body; for uranium, insoluble forms concentrate in the lungs and remain there for a relatively long time. Urinalysis would not detect intakes of insoluble uranium reliably and at sufficient sensitivity. However, lung-counting methods are not particularly sensitive and are suitable only for assessing relatively large intakes retrospectively. In vivo monitoring was performed on a sampling basis and, in the early years, typically relied on volunteers from work areas subject to uranium exposure. Film badges were used from the beginning of Plant operation to monitor personnel exposures to beta and gamma radiation, although prior to 1960, only selected workers were included in the film badge service based on their work activities.

In the mid- to late 1970s, health physics surveys of work practices, continuous airborne activity monitor analysis, and contamination surveys were routinely documented. Health physics personnel were aware of the presence of and hazards associated with neptunium-237, plutonium-239, and technetium-99, and actively encouraged proper respirator use, identifying instances of improper respirator use and recommending other changes to improve ventilation and minimize exposures. The sophistication and rigor of health physics surveys improved during the late 1970s; uranium, uranium daughter products, neptunium-237, plutonium-239, thorium-230, and technetium-99 were monitored, reported, and discussed with personnel. In the mid-1980s, the NRC and DOE were promulgating more stringent regulations for radiological control, and practices related to respiratory protection, contamination control, and personnel monitoring improved considerably.

2.6 Waste and Material Management

Over the years, solid wastes were disposed of in various locations including two landfills, four scrap yards, and three radioactive materials disposal sites. In addition, there were a number of smaller holding areas and special disposal sites. A burn pit in the northwest corner of the site was used for combustible waste until 1967. The landfill used for early construction rubble north of the Plant continued in operation as the Plant came on line, and another landfill outside the fence southwest of the Plant (known as the C-746 K Landfill) was created for steam plant ash disposal and evolved into a general landfill. Although there were some early specifications limiting placement of radioactive material in the landfills, there is no record of sampling to demonstrate compliance. Further, since records indicate that floor sweepings were disposed of in the landfills and spills of green salt and yellowcake were routine in several areas of the Plant, it is clear that radioactive materials were improperly sent to the sanitary landfills. In addition, waste materials (including radioactively contaminated materials) were disposed of in various areas outside the Plant boundary in what is now the Kentucky Wildlife Area. These areas are accessible to the public for recreational use. Unauthorized salvaging of scrap materials also occurred.

Some of the materials disposed of outside the Plant boundary have been identified as radioactive by subsequent site surveys or investigations carried out under the Federal Facility Agreement and by this investigation team. Scrap metals from C-340, the cascades, the feed plant, and the C-720 maintenance shop went to C-746F (classified burial), C-746E (contaminated material yard), C-746C (clean materials), or unclassified burial yards all within the security fence. From the beginning of Plant operations, efforts were made to control the spread of contamination and to separate contaminated materials from other waste. However, records and interviews indicated that compliance was inconsistent and monitoring minimal. Pyrophoric uranium metal shavings were disposed of in the C-749 burial ground from 1957 to 1977. In the 1950s, uranium powder scrap from C-340 was dumped into onsite pits. The primary radioactive waste disposal site was the original C-400 holding pond, which was

converted into a solid waste disposal area in 1957. By 1977, over 6 million pounds of uranium had been put into drums and placed in this disposal area.

PGDP had no integrated waste management program until the early 1980s. Before then, waste disposal was performed by each organization performing work in conjunction with the Maintenance Department, which operated several disposal sites. When requested by the operating departments, limited guidance was provided by the site safety and health organization.

In 1978, the site Environmental Control Department conducted a study of PGDP waste management practices. The report recommended better management of solid waste, closure of miscellaneous burial areas, improved management of existing facilities, provision of additional space for facilities, and construction of facilities for recovery and reduction of waste. The report stated that the passage of the Resource Conservation and Recovery Act (RCRA) in 1976 required Federal facilities to comply with all state solid waste regulations and that the Plant "is only partially meeting both present and planned regulations." In part, this study led to the creation of the Material Terminal Management (MTM) Department within the Maintenance organization. The MTM Department implemented the integrated waste management program by gaining control of waste management facilities and developing waste management procedures for the Plant.

The 1978 study and the formation of the MTM Department also impacted the disposal of radioactive waste on site. In 1978 and 1979, the amount of radioactive waste disposed of on site was 330,690 pounds annually, but this declined significantly to 18,000 pounds per year in the 1980s. An overriding assumption regarding the stability of the radioactive disposal sites was that the underlying clay layer would prevent contamination from leaching into the groundwater and travelling off site.

In the early 1980s, the MTM Department began addressing hazardous waste disposal practices by working with waste generators to ensure that waste streams would be in compliance with RCRA requirements and by implementing standard practice procedures for waste management. Concurrently, the MTM and the Environmental Control Departments worked with regulators to obtain permits for storage, treatment, and disposal facilities, including the C-400 gold dissolver precipitation system and C-410 neutralization pit. Legacy hazardous waste was brought to several locations, including the C-733 Hazardous Waste Storage Area, the C-746R Waste Solvent Storage Area, and the C-746Q Hazardous Waste Storage Area. However, the absence of sufficient characterization to ensure long-term storage and compliance with disposal acceptance criteria has led to existing hazardous waste storage problems and the need for significant recharacterization.

PCBs, which were in widespread use by the Plant throughout its early history, were not considered a hazard nationwide until the early 1980s. In 1980, the newly formed MTM Department performed the first sitewide PCB inventory in response to new Toxic Substances Control Act (TSCA) regulations on PCBs. By 1982, a PCB program was established that addressed PCBs as an environmental contaminant and a regulated waste.

Based on site records, there was a clear understanding in the 1950s that materials contaminated above certain limits could not be released to the public. Procedures were used to govern the handling of scrap materials, which were generally categorized into one of four groups: classified scrap, unclassified clean scrap, unclassified contaminated scrap, and unclassified nonmetal scrap. However, there was a concern in the mid-1970s that the contaminated items were being released to public parties as part of equipment and scrap sales. In mid-1975 a Scrap Handling Committee was established to evaluate onsite solid waste disposal problems. The source of these problems included the ongoing upgrade program, lack of awareness of the proper procedures – especially among new workers and supervisors – and an increase in the number of entities hauling waste to the scrap yards. The Scrap Handling Committee also examined the effectiveness of equipment and scrap sales to the public, and despite recommendations for improvements, continued problems were evident in 1977. The extent to which proper procedures were not followed, combined with the small number of health physics personnel, suggests that materials exceeding proper radiological limits were likely released off site until the late 1980s.

2.7 Air and Water Emissions

Radioactive air emissions began with startup operations in 1952 and have continued to present. Air emissions from the site were released from process stacks, diffuse and fugitive emission sources, accidental releases, and a limited number of planned releases. No evidence of measurements or monitoring of stack emissions was found prior to 1975. From 1959 to 1974, the air emission reports consisted of ambient air monitoring. Starting in mid-1960, continuous ambient air samples were taken at four locations at the perimeter fence and were analyzed for alpha and beta